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Benefits of Passive Visual Experiences With Trees and Other Vegetation on Human Well-Being and Health

BENEFITS OF PASSIVE VISUAL EXPERIENCES WITH TREES AND OTHER VEGETATION ON HUMAN WELL-BEING AND HEALTH

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between

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INTRODUCTION

About 80% of the American population lives in cities or urban areas. At the same time, most Americans would prefer to live in smaller towns or urban areas rather than in cities of 50,000 people or more (Lou Harris & Assocs., 1978). This implies that for many people the attractions of large cities such as cultural amenities, shopping, and jobs are outweighed by negative aspects such as crowding, crime, noise, long commutes, air pollution, and other stressors. However, for economic and other reasons, many people cannot live where they would like, so there is a clear need for changes in the environments of our cities that would make them more pleasant and liveable.

A widely held notion is that trees, flowers, and other vegetation help make cities better places for people. Unfortunately, the reality is that many of our highly urbanized areas contain little vegetation. While some cities benefit from having moderate amounts of street trees and other urban forest amenities (Kielbaso, 1990), flowering plants and other smaller vegetation are often nearly nonexistent in public urban areas. Most of the people responsible for urban development--developers, politicians, and planners--probably agree that plants contribute to environmental quality. However, there is relatively little scientific research about human-plant interactions, and this can create the impression among decision-makers that there is an absence of tangible, credible evidence regarding the benefits that plants make possible. Unfortunately, intuitive arguments in favor of plants usually make little impression on financially pressed local or state governments, or on developers concerned with the bottom line (Ulrich, 1980). Politicians, faced with urgent problems such as homelessness or drugs, may dismiss plants as unwarranted luxuries. The lack of research on plant benefits has also tended

to reduce spending for plants in other important settings, such as workplaces, health care facilities, and outdoor areas of apartment complexes.

In recent years, however, researchers from several disciplines have begun investigating the benefits of contacts with plants, especially large-sized vegetation, such as trees. The amount of research is still relatively small, but is growing rapidly and has already deepened our understanding of the positive, need-satisfying experiences that plants make possible. Such studies, by contributing tangible, convincing evidence of the benefits of vegetation, may eventually help achieve higher priority for allocating funds to plants in indoor and outdoor environments: where people live, work, learn, or receive health care. In particular, scientific research that documents the role of plants in fostering human physiological well-being will probably prove to be one effective direction for gaining higher priority for plants.

People derive benefits from plants in a wide range of situations, and through active contacts or involvement such as gardening and more physically passive experiences such as viewing flowers in a park or looking at plants through a window. This paper mainly focuses on the influences of visual contacts with plants on psychological and physiological well-being, and on health-related indicators. Particular emphasis is given to stress reducing benefits of viewing vegetation. As will become evident from the survey of research in later sections, most research findings to date pertain to large-sized vegetation such as trees or mixed vegetation dominated by trees and shrubs. Comparatively little research has been carried out to evaluate benefits derived from viewing small plants and flowers. In what follows, we first review theories from the social sciences that are relevant to explaining possible beneficial influences of visual contacts with vegetation. Subsequent sections review findings from related fields, such as urban forestry and environmental

psychology, which suggest that settings dominated by large vegetation such as trees have stress reducing and other beneficial effects. These findings bolster intuitions about possible benefits of flowers and other small plants in public and private settings. The review of findings relating to vegetation is divided into four parts: (1) aesthetic benefits; (2) effects on psychological well-being, including stress reduction; (3) physiological influences; and (4) health related benefits. A final section discusses promising directions for research on flowers and small plants, taking into account recent technological advances that create unprecedented opportunities for performing sound, scientific studies of the role of plants in fostering human well-being and health.

BELIEFS AND THEORIES

The beliefs that contacts with trees, grass, and flowers foster psychological well-being, and help reduce the stresses of urban living, seem to be as old as urbanization itself. The villa gardens of the ancient Egyptian nobility and the walled gardens of Persian settlements in Mesopotamia indicate that the earliest urban peoples went to considerable lengths to maintain some direct contact with nature (Shepard, 1967). There are numerous early writings suggesting that vegetation and other nature were valued in cities. For instance, in the 1st Century B.C., the Roman poet Horace wrote regarding city dwellers: "Why, amid your varied columns you are nursing trees, and you praise the mansion which looks out on distant fields" (quoted in Glacken, 1967).

In the United States in the 1860s and 1870s, the renowned landscape architect Frederick Law Olmsted wrote at length about his intuitively-based conviction that visual contact with nature, including plants, is beneficial to

the emotional and physiological health of city dwellers. He asserted that an environment containing vegetation or other nature "employs the mind without fatigue and yet exercises it; tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system" (1865). Olmsted's strong belief that vegetation and other nature in cities bring "tranquility and rest to the mind" was an important part of his eloquent justification for providing parks and vegetation in America's cities. Along with the famous parks he helped create, such as New York's Central Park, Olmsted's ideas about the healthful, restorative effects of nature in cities were a major influence on the City Beautiful movement and had widespread effects on parks and urban landscaping that continue down to the present.

Contemporary Theories

A century after Olmsted, authors from both the social and natural sciences have advanced a number of quite different theoretical perspectives that are relevant to explaining why people may derive enhanced well-being from passive contacts with flowers, trees, and other plants. Importantly, all these theoretical viewpoints, despite their differences, agree in predicting that passive experiences with environments having vegetation or other nature should tend to have positive effects on psychological and physiological well-being (Ulrich and Simons, 1986). A related point is that these theories all imply that contacts with environments having vegetation, compared to the effects of urban or built settings lacking nature, should usually be effective in fostering restoration from stress.

Overload and arousal theories have differences, but both propose that environments with high levels of visual complexity, noise, intensity, and movement can, respectively, overwhelm and fatigue human perceptual

systems, or lead to detrimentally high levels of psychological and physiological excitement (e.g., Cohen, 1978). Both theories imply that restoration from stress or perceptual fatigue should be fostered by settings having stimuli, such as plants, that are low in intensity and incongruity, and have patterning that reduces arousal and processing effort (e.g., Berlyne, 1971). There is some evidence that settings dominated by vegetation tend to have lower levels of complexity and other arousal increasing properties than urban settings lacking nature (Wohlwill, 1976). Accordingly, these theories imply that surroundings containing prominent vegetation, compared to the effects of intense, perceptually jumbled urban settings, should have positive, stress reducing effects on people.

Alternatively, another important category of theories emphasizes learning as the key mechanism for acquiring positive responses to plants and other nature. For instance, it might be argued that many individuals acquire positive associations with vegetation and other nature during vacations and other recreational experiences in rural areas. On the other hand, many people probably learn negative or stressful associations with urban environments because of such negative phenomena as crime or traffic congestion. An example relating more specifically to plants would be that learning and familiarity presumably explain why Arizona residents have more positive attitudes or responses to succulent shrubs and other desert plants than do Americans living in temperate parts of the country (e.g., Hecht, 1975). Cultural explanations emphasize learning as the basis for an individual being conditioned or taught by society to prefer certain environmental elements and dislike others or find them unsettling. A cultural argument could be used to explain, for instance, why the French may tend to like topiary, or why many Americans apparently prefer foundation plantings in their

front yards. More generally, different authors have concluded that Western cultures condition their populations to like nature, including vegetation, and have negative associations with cities (e.g., Tuan, 1974). Hence cultural and other learning based perspectives can suggest at least partial explanations for a given society's positive disposition to vegetation generally, and for greater liking for one particular plant variety over another.

However, cultural and other learning based perspectives are inadequate for explaining why widely diverse cultures may believe in the restorative influences of nature. Such theories also show weaknesses in the face of growing empirical evidence indicating there can be impressive similarity across Western and non-Western cultures in terms of greater liking for natural scenes in contrast to views of urban or built environments (e.g., Hull and Revelle, 1989). Cultural explanations help to account for how responses or associations with respect to environmental elements are transmitted and maintained within a society, but they do not adequately explain, for instance, why the belief originated in a culture that contact with vegetation is restorative.

In recent years, authors have increasingly advanced <u>evolutionary</u> theoretical positions. The surge in evolutionary thinking is due partly to the fact that these perspectives are easily reconcilable with research findings indicating cross-cultural agreement in liking for vegetation and other nature. Further, evolutionary arguments contribute explanations for content-specific restorative influences and preferences (e.g., stress reducing effects of vegetation as a general category of environmental content). Although evolutionary arguments can have pronounced differences, a premise shared by most authors is that the long evolutionary development of humans in natural environments has left its mark on our species in the form of

Regarding stress reducing effects of vegetation, authors from different fields have postulated that strong attention holding properties of nature may be an important mechanism in restoration. As a prominent example, Frederick Law Olmsted wrote insightfully about mental stresses and fatigue associated with cities and "modern" life, and conjectured that natural views foster restoration because of their capacity to hold attention and block out the demands and distractions of daily work and living: "The attention is aroused and the mind occupied without purpose" (1865). The Kaplans have used William James' concept of "involuntary attention" in arguing that people respond with strong attention or "fascination" to nature, and this fosters restoration from mental fatigue associated with tasks or conditions that require sustained, disciplined, or taxing attention (Kaplan and Kaplan, 1989). Arguing from an evolutionary perspective, Katcher and his associates (Katcher et al., 1983) have suggested that a major reason why relaxation is induced by viewing a different type of natural configuration--an aquarium with fish--is that nature is effective in holding attention, diverting people's awareness away from themselves and from worrisome thoughts, and eliciting a meditation-like state. As will be discussed in a later section, Ulrich has performed a sequence of studies that have yielded direct empirical evidence suggesting that nature scenes dominated by vegetation, compared to urban scenes without vegetation, effectively hold attention and interest (e.g., Ulrich, 1979, 1981). However, these studies also indicate that along with attentional effects, vegetation elicits emotional and physiological responses that play critical roles in restoration.

To summarize briefly, the old belief that passive exposure to plants and other nature fosters human well-being is echoed in a number of contemporary theories that offer different explanations for positive

responsiveness to nature. Although the present authors consider evolutionary or unlearned factors to be of primary or most general importance, arousal/overload and learning-based explanations also have certain merits and can contribute to a more complete understanding of human responses to plants. Restorative and other beneficial effects of plants probably arise from a combination of factors and mechanisms, including evolutionary or unlearned influences, learning, and arousal-reducing properties of plants related to complexity and intensity levels that are non-taxing or require little processing effort.

PSYCHOLOGICAL WELL-BEING

Aesthetic Benefits

One comparatively narrow but important category of psychological benefits of plants, and the one that has received the most attention from researchers, is the aesthetic. If viewing a setting with plants elicits a response of aesthetic liking or preference, then presumably an individual's feeling state may be somewhat more positively toned (Ulrich, 1990). Consistent with predictions suggested by the various theoretical perspectives described above, many studies conducted in different countries have shown that people usually accord higher liking to nature scenes dominated by vegetation that to urban scenes lacking vegetation (e.g., Kaplan and Kaplan, 1972; Zube et al., 1975). Within American urban environments, the presence of trees, grass, and other plants in settings usually increases aesthetic liking. Similarly, research in Japan and Western Europe suggests that urban scenes having vegetation are more preferred than urban settings lacking vegetation (e.g., Asakawa, 1984). This finding has been reported for such urban settings as residential areas

(e.g., Cooper-Marcus, 1982; Nasar, 1983; Schroeder and Cannon, 1983; Zoelling, 1981); commercial streets and strips (e.g., Lambe and Smardon; 1986), and parking lots (Anderson and Schroeder, 1983). Several investigators have found that parks or park-like features having trees and other prominent vegetation are often especially preferred visual amenities in urban areas (e.g., Ulrich and Addoms, 1981). By contrast, urbanites respond with moderately low liking to empty grass-covered spaces lacking trees and other vegetation. In parks, aesthetic liking is particularly high for well-maintained areas having visual openness, scattered trees, and understory plantings that do not obscure foreground surveillence or create enclosure. Dense understory vegetation that restricts visual openness reduces aesthetic liking sharply and elicits feelings of insecurity (Daniel and Boster, 1976; Schroeder and Anderson, 1984; Hull and Harvey, 1989). Compared to whites, black Americans respond with even lower liking to settings having dense foreground vegetation or with a sense of enclosure (R. Kaplan and Talbot, 1988). (For surveys of research on aesthetic responses to trees and other large vegetation in cities, see Schroeder, 1989, and Smardon, 1988).

Although a substantial body of research has focused on the aesthetic influences of trees and other large vegetation in cities, there is a shortage of studies on aesthetic responses to small plants and flowers. One of the few studies to consider flowers has been performed by Schroeder and Lewis (Schroeder, 1986), who asked members and volunteers at the Morton Arboretum to give verbal descriptions of areas they remembered at the Arboretum. Of the individuals in the study, 90% provided comments indicating that attractive views containing flowers were positive memories of the Arboretum--e.g. "fields of daffodils in an area of large oaks."

Stress Reducing Effects of Settings with Vegetation

A stress reaction is the process of responding psychologically, physiologically, and often with behaviors, to a situation that is taxing or threatens well-being (Evans and Cohen, 1987). Although certain short-term stressful situations can improve human performance and cognitive functioning, stress is considered here to be a negative condition that should be mitigated over time to prevent deleterious effects on human performance, well-being, and health. While preference or aesthetic liking is an important emotional response, it is only one component of the broad range of feelings (e.g., fear, anger, sadness, interest) that are central to the psychological dimension of stress and restoration (Ulrich, 1983).

Consistent with the beliefs of Olmsted and others, and with predictions of the theories surveyed earlier, a large body of research on recreation experiences has indicated that leisure activities in nature settings with vegetation are important for helping people cope with stress as well as in meeting other non-stress related needs. Most of this research focuses on benefits derived from experiences in wilderness environments, but a growing number of studies have assessed psychological effects of leisure experiences in urban parks, botanical gardens, and yards and common areas of housing developments. A consistent finding in more than 100 wilderness studies has been that psychological restoration through stress reduction is one of the most important verbally expressed perceived benefits (e.g., Driver and Knopf, 1975; Knopf, 1987). Similarly, restoration from stress has emerged as a key perceived benefit in most of the research on urban parks and spaces in residential areas (e.g., Davis, 1973; Ulrich and Addoms, 1981; R. Kaplan, 1983; Hayward and Weitzer, 1984; Talbot et al., 1987).

Apart from restoration derived through viewing vegetation and other nature, other mechanisms probably contribute to stress recovery in these studies, including factors such as physical exercise and achieving a "breather" and sense of control with respect to work pressures and other stressors through "temporary escape" (Driver and Knopf, 1975) or "being away" (R. Kaplan and Talbot, 1983). Nonetheless, it appears that part of the restoration derived from such recreation experiences stems from viewing vegetation and other nature. This conclusion is supported by a few park studies that have found statistical associations between reported restoration and questionnaire items relating to a park's appearance--e.g., trees, grass, open space (Ulrich and Addoms, 1981). Also, some research has identified restorative effects while controlling for variables such as physical exercise and psychological "escape." Hartig, Mang, and Evans (1987) produced stress in subjects with a demanding cognitive task, and then measured recovery produced by either (1) reading magazines or listening to music for 40 minutes, (2) a 40 minute walk in an urban area, or (3) walking for an equivalent period in a nature area dominated by trees and other vegetation. Findings showed that individuals who had taken the nature walk had more positively toned feelings than subjects assigned to the other conditions. Schroeder (1986) found that the most common feelings associated with visits to the Morton Arboretum were serenity, tranquility, or peacefulness. Such feelings were often linked to experiences with settings having lush vegetation and openness.

A study framed explicitly as a test of Olmsted's "tranquility hypothesis" has yielded direct evidence of restorative effects of just viewing vegetation. Ulrich (1979) studied two groups of university students who were experiencing mild stress because of a final course exam. One group was shown a collection of color slides of unblighted urban scenes lacking vegetation; the

other group was exposed to slides of rural settings dominated by trees and other vegetation. Consistent with Olmsted's conjecture, findings obtained from self-ratings of feeling states suggested that the vegetation scenes fostered greater stress recovery as indicated by sharp increases in levels of positive feelings, significant reductions in fear, and somewhat lower anger/aggression. Ulrich also found that the settings with vegetation sustained attention more effectively than the urban scenes lacking vegetation. Honeyman (1987) replicated this study with the important change that she tested an additional recovery condition consisting of slides of urban scenes with vegetation. Her findings suggested that greater restoration was produced by the urban scenes with vegetation than the settings without vegetation.

Another line of research, on window views and windowless settings, has provided additional evidence suggesting that visual contact with vegetation and other nature can be preferred and restorative. Compared to settings with windows, windowless rooms tend to be disliked and can be stressful, especially in workplaces and health care settings (e.g., Keep et al., 1980; Ruys, 1970). Heerwagen and Orians (1986) found that office workers with little or no visual access to the outside were more likely to decorate their work spaces with posters and other depictions of outdoor scenes than were workers with windows. Further, most of the outdoor pictures used by the windowless group displayed settings dominated by vegetation and other nature. The windowless workers may have displayed nature pictures to compensate for stressful influences of windowlessness (Heerwagen, 1990). In interiors with windows, views having depth, vegetation or other nature are preferred over low depth and visually impoverished window views (Markus, 1967; Verderber, 1986).

Other evidence implying important restorative effects of nature in stressful interior environments has emerged from interviews with astronauts and cosmonauts. Space vehicles and facilities are isolated, cramped, hazardous, stressful environments. Wise and his associates interviewed a culturally diverse group of Western astronauts and Soviet cosmonauts, asking for suggestions for interior decor options they would prefer (Wise et al., 1988). As summarized by the researchers in their report, the responses indicated a strong, widely shared preference for having more plants and other nature elements in stressful orbital environments:

> ". . . respondents were nearly unanimous in asking for more natural and varied colors, plants, landscape pictures, and natural woods, regardless of their particular national origin. Human beings' love for nature and natural materials and forms, especially in high technology habitats, seems to transcend national boundaries. The Soviets' extensive use of natural scenes and working gardens to maintain morale in their *Salyut* and *Mir* crews is already well documented. . ." (Wise et al., 1990, p. 6).

PHYSIOLOGICAL EVIDENCE OF BENEFITS

In addition to psychological manifestations, stress and restoration have very important physiological dimensions. The physiological component is reflected in responses or levels of activity in numerous bodily systems, such as the cardiovascular. Data obtained by recording physiological responses are widely recognized to have scientific credibility as indicators of stress and restoration. Also, physiological methods can identify influences on well-

being that may be outside the conscious awareness of individuals and hence may not be identified by verbal measures such as ratings or questionnaires.

In a study performed in Sweden (Ulrich, 1981), brain electrical activity was recorded from unstressed individuals while they viewed lengthy slide presentations of outdoor scenes. The major finding was that alpha wave activity was higher when subjects viewed nature settings dominated by vegetation as opposed to urban scenes lacking vegetation. Apart from indicating that the nature and urban scenes had different effects on electrocortical activity, the alpha wave results strongly suggest that the vegetation views were more effective in eliciting a wakeful, relaxed state. In the same study, self-ratings data suggested that the vegetation settings sustained attention/interest at higher levels than did the urban scenes, and produced more positively toned emotional states.

Physiological measures have also been used to study directly the question of stress reducing effects of visual experiences with nature. Ulrich and Simons (1986) monitored a battery of physiological responses while stressed subjects experienced a "recovery" period consisting of 10-minute color/sound videotapes of either natural or urban outdoor environments. Results indicated that people recovered more quickly and completely from stress when exposed to the natural settings, which included a park-like setting dominated by vegetation. Greater recovery during the nature exposures was indicated by lower blood pressure, muscle tension, and skin conductance. The heart rate response was of particular interest in this study. Heart rate data suggested that the natural environments elicited considerable attention or perceptual intake, while the urban settings were perceptually rejected. The nature settings also fostered more recovery in the psychological component of stress as suggested by greater reductions in self-rated fear and anger, and

much greater increases in positive feelings. The physiological findings indicated that the nature settings produced significant recovery from stress with only 4-6 minutes. This rapid recovery raises the possibility that comparatively brief visual contacts with vegetation might be important for many city dwellers from the standpoint of fostering restoration from mild daily stressors such as commuting and work pressures.

Recently, researchers have begun to use physiological measures to investigate stress reducing effects of nature scenes in certain health care and workplace settings. Heerwagen and Orians studied stressed patients in the waiting room of a dental fears clinic (Heerwagen, 1990). On some days the researchers hung a large mural on a waiting room wall depicting a view of distant mountains, clustered trees, and open grassy areas. On other days, the wall was blank. Findings obtained from self-ratings of feelings suggested that patients felt calmer or less stressed on days when the scene with vegetation and other nature was on the wall. Likewise, heart rate measurements also indicated that individuals were less stressed or tense when the nature scene was visible.

Wise and Rosenberg (1988) studied the role of nature decor in alleviating physiological stress in the context of work productivity of astronauts in a space station. Subjects were studied individually as they performed a series of stressful tasks in a simulated space station crew cabin at a NASA center. Each subject was exposed to one of four different pictures that was affixed to a cabin bulkhead: savannah-like nature; mountain waterfall; "hi-tech" abstract; and no picture (control). Although the mountain water scene was most aesthetically preferred, physiological data (skin conductance) suggested that the savannah-like scene was significantly more effective than any of the other visual conditions in mitigating stress. A most interesting

finding was that the presence of the savannah scene apparently reduced stress even when subjects were not looking at it, or perhaps were not consciously aware of the scene. To account for this effect, Wise and Rosenberg speculated that the savannah scene elicited a positive affective state which then provided a persistent buffer against stress during task performance. Similarly, findings from the dental fear clinic study described above raised the possibility that patients did not have to be looking at the nature scene, and perhaps not even be consciously aware of its presence, to derive restorative benefits (Heerwagen, 1990).

These physiological findings justify the speculation that people may not have to be consciously aware of the presence of plants in homes, workplaces, or other settings for the plants to have positive influences on emotional states and physiological indicators. Another implication of these physiological studies is that research approaches based on verbal ratings or evaluations of physical settings having plants (e.g., satisfaction or pleasantness ratings of a setting) may sometimes not reveal effects of plants on well-being.

HEALTH RELATED BENEFITS

Findings surveyed in the previous sections suggest that short-term exposures to vegetation can be effective in fostering recovery from mild stress. Accordingly, it seems possible that the potential benefits of viewing trees, flowers, and other vegetation may often be greatest when individuals experience considerable stress or anxiety and are required to spend long periods in a confined setting (Ulrich 1979, 1981). Such situations include, for instance, health care contexts, prisons, and certain high stress work environments. In these and other settings, long-term exposures to views of

vegetation and other nature may have persistent positive influences on psychological and physiological well-being, functioning, and possibly behaviors--which in turn might be reflected in health related indicators.

Findings from a few studies focusing on prisons and hospitals suggest that window views of vegetation or other nature can have important health related benefits. Moore (1982) examined the need for prison health care services by inmates whose cells looked out onto the prison yard and those who had a view of nearby farmlands and forests. He reported that inmates who had the natural view were less likely to report for sick call. Likewise, West (1985) found that cell window views of nature, compared to views of prison walls, buildings, or other prisoners, were associated with lower frequencies of health-related stress symptoms such as headaches and digestive upsets. Ulrich (1984) compared the hospital records of matched pairs of gall bladder surgery patients who had window views of either a small stand of trees or a brick building wall. He found that patients with the view of trees had shorter post-operative hospital stays, required fewer potent pain drugs, and received fewer negative staff evaluations about their conditions than those with the wall view.

Studies such as these using health-related measures suggest opportunities for linking economic benefits to passive experiences with vegetation and other nature. For instance, because patients in the hospital study required fewer costly pain injections, and prisoners needed fewer health services, it seems likely there are dollar savings benefits associated with the views of nature.

RESEARCH DIRECTIONS: ADVANCES IN METHODS AND EQUIPMENT

There have been major advances recently in the development of research equipment and new techniques that have created unprecedented opportunities for performing sound, quality research on beneficial influences of contacts with plants. These advances will enable researchers, for instance, to apply physiological and health-related procedures in a broad range of real-world as well as laboratory situations--e.g., home interiors, backyard gardens, workplaces, health care facilities, botanical gardens, shopping malls, and urban settings. However, achieving this potential will require increased availability of research funding, and the bringing together of multidisciplinary research teams having the necessary range of expertise.

Many of the new opportunities stem from advances in electronics miniaturization and computers that are making the recording of important physiological indicators (e.g., blood pressure, heart rate) increasingly practical for investigating the effects of plants on well-being. Compact, self-contained unobtrusive units can be worn by individuals and record or transmit data as they experience settings having flowers or other plants. Eye-tracking equipment has become available that is comparatively inexpensive and unobtrusive, and can be worn by individuals, for instance, while they walk through gardens or drive through urban areas. Eye-tracking apparatus makes it possible to study such issues as the extent to which people notice and pay attention to flowers and other plants. This information could have considerable practical value in guiding decisions, for example, about where to locate ornamental plantings in parks or pedestrian shopping areas so that the visual impact is maximized. Eye-tracking studies would also be very useful in generating guidelines regarding size and siting requirements for roadside

plantings, to insure that fast-moving motorists notice and benefit from the plants.

There has also been rapid progress in developing techniques for simulating environments for research. For instance, the Visualization Laboratory at Texas A&M University has the capability to realistically present real or imagined environments using computer graphics and animation. Settings can be displayed with realism potentially equivalent to photographic quality in three-dimensional color graphics that may be either static or animated. This technology enables researchers, for instance, to study individuals' reactions to scenes that vary systematically with respect to the presence of plant species or flower colors. Animation techniques make it possible for an observer at a large monitor to "walk through" a garden or shopping area, or "drive through" an urban area before and after plants or other landscaping are added. These kinds of advances, both in environmental simulation and in techniques for scientifically measuring effects on well-being, should open doors to significant progress in understanding human benefits of plants.

SUMMARY AND CONCLUSIONS

This paper has discussed theory and research findings relating to the old belief that visual contact with plants and other nature is somehow good for people, and can help individuals cope with the stresses of urban living. Contemporary theories, whether they emphasize learning or evolutionary explanations, agree in predicting that visual contacts with environments having vegetation or other nature should tend to have positive effects on psychological and physiological well-being. Progress has been made in

investigating benefits derived from visual experiences with trees and other large vegetation; however, little work has focused on the role of views of flowers and small plants in fostering psychological and physiological well-being. It appears that relatively little is known in a scientific sense about such issues as aesthetic preferences for different small plants, effects of viewing small plants on emotional states and stress recovery, physiological influences of viewing flowers, or possible health-related effects associated with long duration or frequent exposures to flowers and other plants.

A large body of research has shown that the presence of trees and other large vegetation in urban settings enhances aesthetic liking or preference. Also, a growing number of studies have found that viewing nature scenes dominated by vegetation has beneficial effects on psychological and physiological well-being, and in certain situations can have positive effects on health-related indicators. In laboratory research, visual exposure to settings with vegetation has produced significant recovery from stress within only about 5 minutes, as indicated by changes in physiological measures such as blood pressure and muscle tension. Views of vegetation foster restoration from stress apparently because of a combination of beneficial effects: they produce increases in positive feelings; reduce negatively toned or stress-related feelings such as fear, anger, or sadness; hold interest/attention effectively and hence may block or reduce stressful thoughts; and elicit positive changes across different physiological systems. This combination of positive psychological and physiological effects observed for short duration exposures may underlie beneficial health related influences of vegetation views found in studies of stressful real-world settings such as hospitals and prisons. Vegetation views that are comparatively effective in reducing stress may not always be those that rate highly in aesthetic preference. While direct

visual attention is important in restoration, recent findings raise the possibility that stress reduction may persist without attention, and perhaps not even require conscious awareness that plants or views of vegetation are in the room or workplace, or whatever the individual's immediate surroundings. In any case, it seems clear that the importance of viewing vegetation goes far beyond aesthetics to include a range of other important effects on well-being.

Among other research needs, advances in understanding the benefits of plants will require many more studies that assess effects on well-being using physiological and health-related measures. The advantages of this research direction are being enhanced by rapid advances in electronics miniaturization and computers that make it possible for researchers to use physiological procedures more easily in real-world settings (e.g., gardens, workplaces, health care facilities) as well as in laboratory situations. Research on plants benefits that uses physiological and health-related methods offers important advantages. For instance, research findings obtained from physiological procedures (e.g., blood pressure effects) tend to have scientific credibility, often carry weight in decision-making and in environmental impact statements, and can be considered permissible data by courts--where such findings can sometimes be reconciled with legal interpretations of public health and welfare. If researchers wish to study the effects of plants on well-being or health, then methods or measures should be used that directly relate to well-being and health, including physiological and other methods used in such fields as health psychology, clinical psychology, and behavioral medicine. By contributing tangible, convincing evidence of the importance of plants for human well-being and health, future research using physiological and health-related methods will probably prove useful to

horticulturists in helping them gain higher priority for plants in spending or allocation decisions.

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